

Cost-Effective Clinical Uses of Wide-Area Networks: Electronic Mail As Telemedicine

Eugene R. Worth, M.D.¹, Timothy B. Patrick, Ph.D.^{1,2},
J. Craig Klimczak, D.V.M., M.S.^{1,3}, John C. Reid, Ph.D.¹

¹Medical Informatics Group, ²Department of Information Science,

³Health Services Management

University of Missouri-Columbia

Electronic mail (E-mail) is widely used as a means of communication in the medical community. E-mail is clearly inexpensive when compared to two-way, fully interactive, real-time, video telemedicine. By content analysis of 200 consecutive messages, we show E-mail to be a low-cost use of computer networks, supporting a wide range of physician decision-making.

INTRODUCTION

Wide-area computer networks have the power to provide physicians with access to an abundance of electronic medical information. This information is available in a variety of forms that may be used to support clinical decision making. The use of wide-area networks to support clinical decision making is an example of *telemedicine*, viz., the practice of medicine at a distance (*tele*). *Telemedicine* is commonly used to stand for a collection of high resolution televideo equipment, with adapters for visual and auscultatory examination. However, *telemedicine* may be broadly defined as "the use of telecommunications technologies to provide medical information and services".¹ For example, the National Library of Medicine holds a broad conceptual view of telemedicine which includes three essential elements: (1) clinical decision support; (2) physiologic or image signal processing; and (3) legal or credentialing arrangements between institutions which enhance remote medical practice.²

Telemedicine involving two-way, real-time video and sound consultation provides support for clinical decision making in extremely time-critical contexts. Decision making in less time-critical contexts may be served by less expensive and more widely available modes of telemedicine.³ This study is the first in a series examining cost-effective uses of wide-area networks to support clinical decision making. In particular, this study examines the use of E-mail as low-cost telemedicine. Our conclusion is that E-mail constitutes an inexpensive and cost-effective source of clinical decision support for a wide range of issues of

ongoing clinical concern.

We describe a content analysis of two hundred consecutive E-mail messages to the Anesthesiology Discussion Group. The Anesthesiology Discussion List (GASNet[®]) was formed in May, 1993.⁴ Subscription to the GASNet[®] list server is controlled; however, the discussion list is not moderated. A professional affiliation in the field of anesthesiology is required to join the discussion list.⁵ Monthly transaction digests have been available since October, 1993. We chose this discussion list because one of the authors (ERW) has expertise in the field, and anesthesiologists practice in relative isolation from large numbers of peers. GASNet[®] has over nine hundred subscribers from around the world. More than six hundred messages per month, with monthly digests requiring one and one-half megabytes of disk space, are stored on the list server.

METHODS

Our study proceeded in two steps. In step one a "pile sort" was used to develop categories for a content analysis. In step two a "content analysis" was performed on two hundred consecutive E-mail messages from the GASNet[®] digest for January, 1995.

Step One: Pile Sort

Three of the authors (ERW, JCK, and JCR) used a pile sort to develop the categories for the subsequent content analysis.

A pile sort is used to identify categories of information not explicit in the original source material. A pile sort allows the expert to sort and rank new items of information into an organized knowledge structure. This is an ethnoscience method of knowledge acquisition which categorizes information from an unknown domain.⁶ Items of knowledge are written on note cards and are stored until many items of the domain are known. The expert sorts these note cards into as many piles as he or she wishes. Each pile is

then subdivided as far as possible. The expert is then asked to identify the logic he or she used when grouping the note cards.

Thirty GASNet[®] messages were scrutinized for all pieces of information judged relevant. Each item of information was cataloged on a separate index card. The cards were pile sorted and content categories were established.

The following content categories were used: date, day of the week, local time stamp, country code (for foreign submissions), Internet connection source (for United States submissions), a question, a response, a response with a secondary question component, clinical focus, administrative focus, non-clinical focus, knowledge source, subject, and current case. The following knowledge sources were used: established standards, literature quotations, personal experience, and hearsay. The category of knowledge source was used for responses only. The subject of a message was represented by noun phrases taken from the subject line of each message or abstracted from the body of the message text. We did not, in this preliminary study, restrict ourselves to classifying the subject of a message with terms from a controlled vocabulary.

Step Two: Content Analysis

Content analysis is a "research technique for the objective, systematic, and quantitative description of the manifest content of communication."⁷ Content analysis has been used to study conference proceedings in medical informatics.⁸

Two of the authors (ERW and TBP) performed a content analysis on two hundred GASNet[®] messages that had been posted over a fourteen day period. Interrater reliability was established by consensus meetings where differences in categorization were discussed. Agreement was obtained and final assignments to categories were made. A spreadsheet template (Microsoft[®] Excel[™]) was used for tabulation and analysis of results.

The application of the following categories was open to interpretation: clinical focus, administrative focus, non-clinical focus, knowledge source, subject, and current case. Exemplars of these categories were used as aids in the content analysis.

The following is an example of a clinical question and answer pair: **Question:** "We recently had an interesting obstetrical case. A 28 yr old, healthy g1p0 [gravida 1, para 0] had a dural puncture during the

course of epidural analgesia for labour. She subsequently developed a postural headache and three days later had a blood patch which relieved her symptoms. 36 hours later (five days after delivery), she had a single grand mal seizure. All investigations were negative." **Answer:** "I have seen one patient presenting like this who turned out to have a cavernous sinus thrombosis and intracranial hypertension. In this patient, the blood patch did NOT fix the headache. Intensive care management, however, was effective."

The following is an example of an administrative question and answer pair: **Question:** "Here's a look into the future for us all! The biggest HMO here wants to go to fixed dollar amounts for each non-primary care specialty, starting in the spring. 'Turbo capitation,' if you will. We've been telling them that in anesthesia, we don't control the length of surgery, that some surgeons are very slow, that the hospitals are too different (some tertiary care, some not), etc. Anyone dealt successfully (or otherwise) with this before?" **Answer:** "Yes, Nancy Reagan had a suggestion: 'Just say no.' Alternatively, I suppose I'd go back to our database, figure out the mean and s.d. [standard deviation] charges for procedures by CPT code and decide what could be acceptable. Perhaps, with an insistence on a stop-loss for extreme outliers. Would expect to save some money on billing procedures as well with a flat rate by CPT."

The following is an example of a message with no clinical focus: "**** and **** please send me your email address. I apologize to the group at large for violating the space for a personal need. thx [sic]."

The following is an example of a standards knowledge source: "The JCAHO refers to conscious sedation protocols. . . ." The following is an example of a literature citation knowledge source: "Gertie Marx in *The International Journal of Obstetric Anesthesia*, 1991 describes a case very similar to yours. . . ." The following is an example of a personal experience knowledge source: "This reminds me of an unforgettable case I had. . . ." Finally, the following is an example of an anecdotal or hearsay knowledge source: "When I was a resident, my attendings always said. . . ."

The following example illustrates the classification of a message by subject: "Has anyone had experience using the Level I infuser and problems with air in the system during massive transfusion of blood/fluids?" **Subject:** Level I infuser, massive transfusion, blood and intravenous fluids.

The following is an example of a current case: “*We have a 70 year-old man being considered for carotid endarterectomy. . .*”

RESULTS

We analyzed frequency of messages for the day of the week. Monday, Wednesday, Friday, Saturday, and Sunday had 10 to 15 messages per day, while Tuesday and Thursday logged 20 messages per day. (Figure 1)

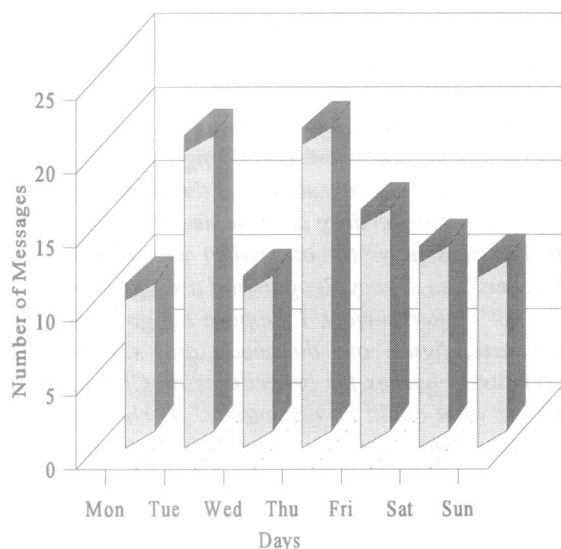


Figure 1 Daily Use

Hourly use was also analyzed. Usage peaks were noted at 12:00 noon, 2:00 pm, 5:00 pm, and 7:00 pm. A distinct nadir occurred between 2:00 am and 5:00 am.

Relative nadirs occurred at 7:00 am, 11:00 am, 1:00 pm, 3:00 pm, 6:00 pm, and 9:00 pm. All dates and times have been normalized to the local time of the sender. (Figure 2)

Thirty-two messages (16%) had international country codes in their Internet addresses, while 168 (84%) were from the United States. Participants outside the United States represented Canada, United Kingdom, Netherlands, Austria, Sweden, Israel, Australia, New Zealand, and Zambia. Of messages judged to be from the United States, the Internet address of 97 messages (57.7%) had an .edu suffix, 52 (30.9%) had a .com suffix, 14 (8.3%) had a .net suffix, 3 (1.8%) had an .org suffix, and 2 (1.2%) had a .gov suffix. Commercial access to the Internet, provided by CompuServe® and

AOL®, had 17 (10.1%) and 14 (8.3%) messages respectively. Other commercial sources made up the final 21 (12.5%) messages.

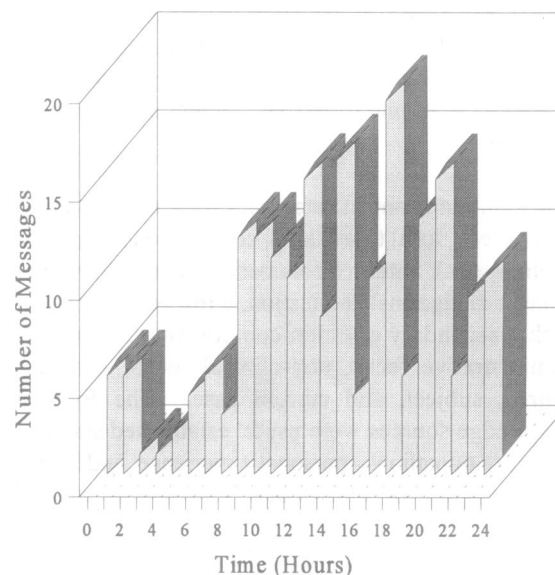


Figure 2 Hourly Use

Two hundred messages analyzed covered 57 distinct topics. There were 49 questions and 150 responses to questions in the 200 messages analyzed. Some messages contained both questions and responses, while other messages, with no clinical focus, had neither. Three “question” messages referred directly to a current case for which the participant desired consultation. The first current case referred to a patient who had sustained a recent myocardial infarction with coronary angioplasty and a cerebrovascular accident. This patient needed an urgent carotid endarterectomy. The physician asked for opinions about clinical management and anesthetic techniques to minimize strain on the heart. The second current case involved a patient who had spinal arachnoiditis. The physician asked for recommendations to help with therapeutic management. The third current case requested information about performing an epidural steroid injection on a pregnant patient. Two responses were received within 24 hours for the complicated vascular case, one within two hours from posting the message. One response was posted three days after the spinal arachnoiditis question. No responses were noted for the epidural steroid case.

Of two hundred messages, 124 (62%) had a clinical focus, 51 (25.5%) had an administrative focus, and 25 (12.5%) had no clinical focus. (Figure 3)

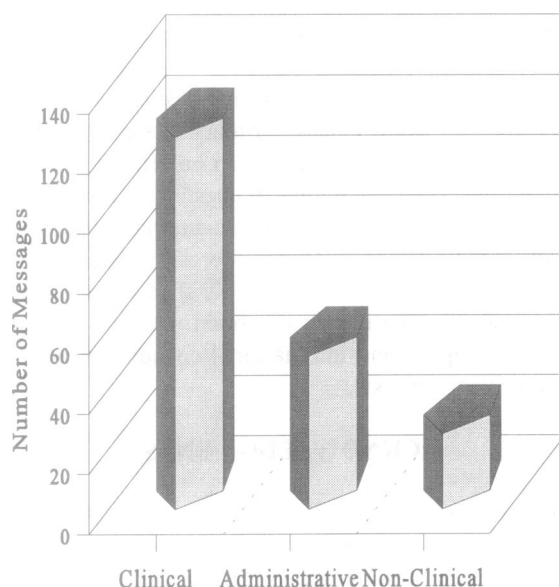


Figure 3 Content of Messages

There were 91 separate participants during our study period covering 14 days of messages. This amounts to ten percent of the list population. Seventy participants sent one or two messages to the list. Fourteen participants sent from three to five messages, six sent from six to nine messages, and one sent fourteen. (Figure 4)

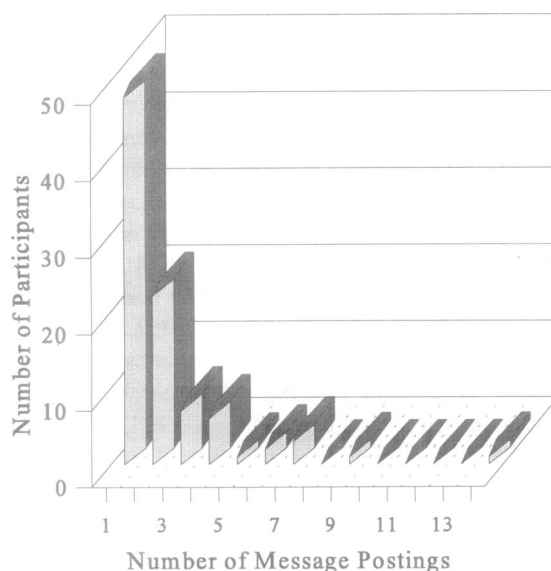


Figure 4 Postings by Participants

Of 150 responses, the knowledge source of 5 (3.3%) were established standards, 12 (8.0%) quoted the scientific literature, and 129 (86%) were based on

personal experience. Only 4 responses (2.7%) were based on hearsay.

Several topics elicited long threads of discussion. The discussion of “preoperative laboratory screening tests” included 27 messages. Some of the subtopics of this discussion included cost-effective screening tests, questions about the necessity of repeat electrocardiograms, preoperative patient screening by non-physicians, and outpatient surgery cancellations because of abnormal preoperative laboratory values. Another discussion topic, ambulation by obstetrical patients having continuous epidural analgesia, generated 23 messages. In the main discussion, technical issues included management techniques which avoid lower extremity weakness while providing adequate analgesia for the parturient. Subtopics included a policy discussion about providing epidural analgesia for midwife deliveries, associated malpractice liability for epidural analgesia in the midwife setting, and issues surrounding informed consent. The discussion evolved into a discussion of whether physicians wore caps, masks, and gowns while inserting epidural catheters. Sixteen messages questioned policies of street clothes in the operating rooms, and a related issue, scrub clothes worn outside the hospital.

Development of conscious sedation policies meeting JCAHO standards was the subject of 14 messages. Finally, the last major thread of discussion included 12 messages and concerned relationships between anesthesiologists and health maintenance organizations. Subtopics included fee structures and antitrust liability.

DISCUSSION

Our purpose was to find out how a group of physicians use E-mail in their interactions with colleagues. E-mail is an informal communications medium, even among consulting physicians. However, although some responses waxed philosophical, most were well-reasoned attempts to appropriately address topics of daily concern, common to many physicians.

Seven of the ninety-one participants posted messages more than five times to the list. One group of individuals sent from six to nine messages. We suspect this to be from personal interest or expertise in the topics under discussion. One participant posted fourteen messages to the list within the two hundred messages analyzed. This is an exceptional case, for which we have no explanation. Participants seemed to respond more frequently when the topic was within

their particular subspecialty interest. During other discussions, they remained quiet observers. The study shows participation by ten percent of the discussion list membership over the fourteen day period.

Most questions and responses concerned pervasive and contemporary topics in anesthesiology. Topics generating many responses were common problems physicians face from day to day: clinical dilemmas concerning effective preoperative screening while trying to conserve expensive medical resources, reimbursement issues in the managed health care market, and problems of meeting multiple needs with minimal personnel resources. These results indicate that E-mail is an effective source of clinical decision support for issues of ongoing concern which do not require an immediate response.

That there were few current cases presented to the discussion list may indicate that E-mail is not suited for consultation about current cases. This may be due to a lengthy time from posting to response. Three current cases were presented to the discussion list. The fastest time from posting to response was two hours, the longest was three days, and one case generated no response. We do not know whether private responses were sent to individual physicians since we only evaluated responses sent to the discussion list.

Our interpretation of the results are subject to two limitations. First, results from this subset of physicians may not be generalizable to all physicians. Anesthesia providers are, by and large, independent practitioners, practicing in small groups over a wide geographical region. Many anesthesia practitioners are the sole providers for their community. Their access to wide-area network discussion lists may be their only regular interaction with others in the specialty. The second limitation is that a time slice of an ongoing discussion list, of necessity, will begin and end in the middle of some threads of discussion.

CONCLUSION

Telemedicine is commonly used to stand for a collection of high resolution televideo equipment, with

adapters for visual and auscultatory examination. This equipment is expensive, and the clinical context may not always warrant such expense. We expect that E-mail cannot effectively support time-critical health care delivery in clinics and primary care hospitals. However, e-mail consultation can be effective in less time-critical contexts, if clinical questions are answered promptly and accurately. Physicians have access to Internet mail lists through commercial vendors for as little as \$9.95 per month. Our study shows that E-mail is a cost-effective means to obtain decision support from colleagues and international consultants in less time-critical contexts.

ACKNOWLEDGMENTS

This work was supported, in part, by grant LM07089 from the National Library of Medicine. The authors wish to thank Keith J. Ruskin, M.D. for his valuable information about the Anesthesiology Discussion List.

References

1. Perednia DA, Allen A. Telemedicine technology and clinical applications. *JAMA*. 1995; 273:483-488.
2. Lindberg DAB, Humphreys BL. Computers in medicine. *JAMA*. 1995; 273:1667-1668.
3. Glowniak JV, Bushway MK. Computer networks as a medical resource. *JAMA*. 1994; 271:1934-1939.
4. Ruskin KJ, Tissot M: A new method of communication between anesthesiologists. *Anesthesiology*. 1993; 79:867.
5. Ruskin KJ, Kofke WA, Turndorf H. The anesthesiology discussion group: development of a new method of communication between anesthesiologists. *Anesthesia and Analgesia*. 1995; 81:163-166.
6. Benfer RA, Furbee L. Knowledge acquisition in the peruvian andes. *AI Expert*. 1989;4:22-29.
7. Berelson B. Content analysis in communication research. Glencoe, Ill.: Free Press, 1952.
8. Dimitroff A. Medical informatics conference papers: A content analysis of research in a new discipline. *Comp and Biomed Res*. 1994; 27: 276-90.